Kootenay 2019 Wildlife Tree Creation Project

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The Fish & Wildlife Compensation Program is a partnership between BC Hydro, the Province of B.C., Fisheries and Oceans Canada, First Nations, and Public Stakeholders to conserve and enhance fish and wildlife in watersheds impacted by BC Hydro dams.

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Background and Treatment Areas

Wildlife trees provide critical nesting, denning, roosting, feeding and perching habitat to over 70 species of birds, mammals and amphibians in British Columbia (Fenger et al. 2006). These include some species which are considered at risk provincially and federally. Dependent on the age, condition and disturbance history of the forested landscape, wildlife trees can be in short supply in some areas. This is the case at the 2019 treatment sites located in the east and west Kootenay region of southeastern BC (Figure 1): Corn Creek (near Creston, BC), Marl Creek (near Donald, BC), and Wycliffe, BC (Luke Creek and Pine Butte Ranch areas). These areas all have high habitat capability for cavity-dwelling wildlife but currently lack complex stand structural attributes and a sufficient supply of wildlife trees in moderate-advanced stages of decay. Increasing stand structural complexity and old growth forest-like attributes, including the abundance of wildlife trees (i.e., large live trees with internal decay and dead trees) are recommended objectives for these areas.

Wildlife tree enhancement treatments were conducted at the above three areas in October 2019, and are expected to increase nesting, roosting and feeding habitat supply for a variety of cavity dependent wildlife species, including Lewis's Woodpecker (*Melanerpes lewis*), Williamson's Sapsucker (*Sphyrapicus thyroideus nataliae*), Flammulated Owl (*Psiloscops flammeolus*), Pileated Woodpecker (*Dryocopus pileatus*) and other cavity-dwelling wildlife species.

Project Goal and Objectives

The overall goal of this project was to enhance wildlife tree habitat supply and quality in the project area. The advantages and benefits of using fungal inoculation as a wildlife tree creation technique have been described by various researchers in the Pacific Northwest (Bull and Partridge 1986; Parks et al. 1996; Lewis 1998; Brandeis et al. 2002; Manning 2008; Manning 2009; Manning 2010; Manning 2011; Bednarz et al. 2013; Hennon and Mulvey 2014; Manning 2018; Manning 2014; Manning and Manley 2014).

Specific project objectives in 2019 were:

i) to enhance overall wildlife tree habitat supply in areas which currently lack wildlife trees; and

ii) to increase the abundance of wildlife trees in areas with high habitat capability for Lewis's Woodpecker, Williamson's Sapsucker, Flammulated Owl, Western Screech-Owl and other cavity-dependent wildlife [e.g., Pileated Woodpecker, Northern Flicker (*Colaptes auratus*)].

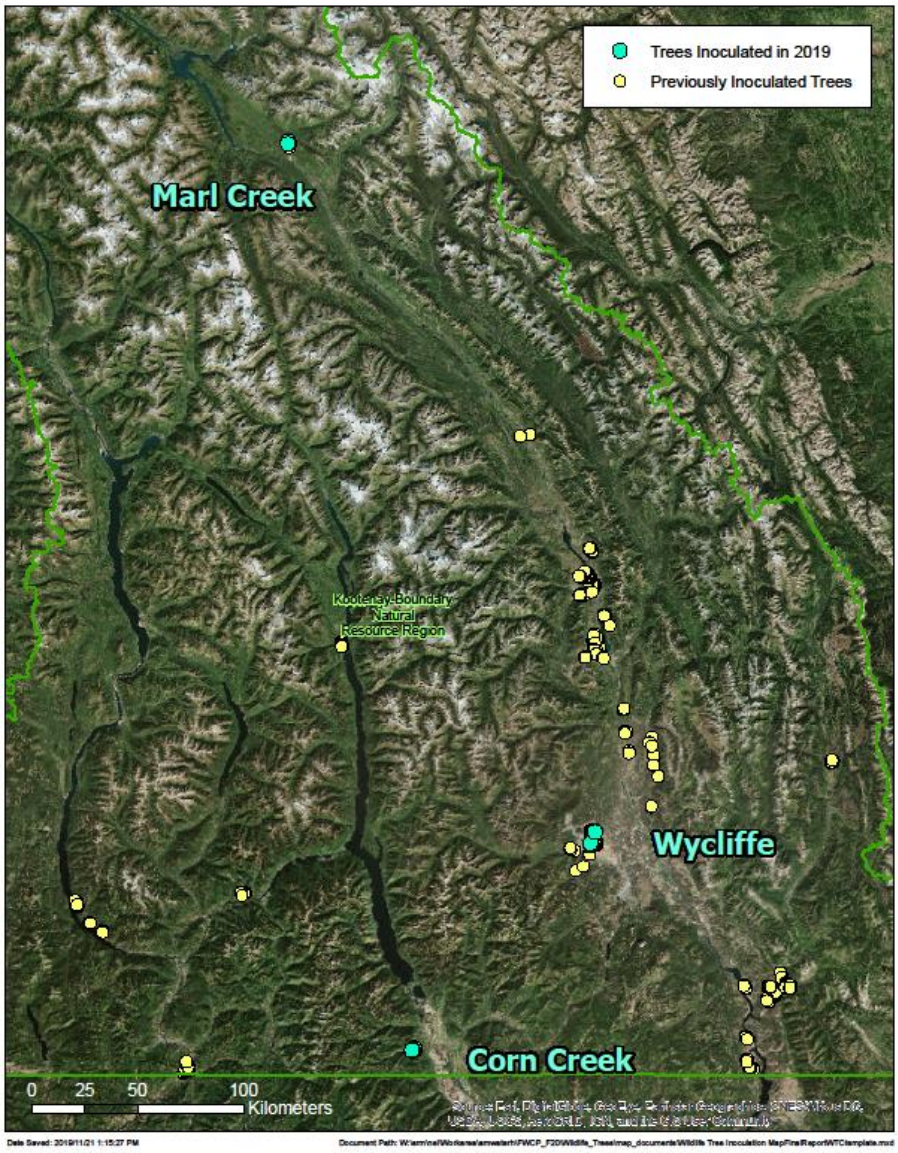

Figure 1. Location of the 2019 fungal inoculation treatment sites (Corn Creek, Marl Creek, Wycliffe area) in the Kootenay region of British Columbia.

Field Methods

Trees intended for treatment were selected, measured and documented (i.e., GPS location, treatment type) in the field concurrently with the wildlife tree creation treatments. Three types of wildlife tree creation treatments were applied to these trees. The first treatment is termed 'window' treatment (Figure 2) – this involves limbing (pruning) a 2-3 m section in the mid-upper portion of the bole (approx. 7-15 m above ground), then applying two ½ circumference stem ring girdles on the same side of the tree bole[1] (intended to stress the tree but not kill it, and more importantly to reduce sapflow and sapwood moisture content in the portion of the stem between the girdles) – this section/side of the stem is then inoculated with the native heart rot fungi *Fomitopsis officinalis (*for Douglas-fir or western larch) or *Phellinus pini* (on Douglas-fir only),

which had been previously cultured in the lab on 8 cm x 1.3 cm wooden doweling. In addition, the stem is "scarred up" with a chainsaw in order to further stress the tree and to provide a visual stimulus to cavity excavators that this part of the tree trunk is potentially damaged/decayed.

The second treatment called 'dead top' involves removing the original live tree top (growth leader) and leaving a 2-4 m limbed section as the remaining top; a full-ring stem girdle[1] is applied immediately beneath this section in order to kill the upper part of the tree; this upper section is then inoculated with *Ganoderma applanatum* or *Fomotopsis pinicola* which are heartrot fungi that can colonize dead woody tissue in deciduous and coniferous trees (Allen et al. 1996).

The third treatment, called 'tall stub' treatment, was primarily applied to some of the larger diameter western larch (i.e., generally >50 cm dbh, Figure 3), particularly those which had few existing limbs in the lower ½ of the tree bole, and also extensively to trembling aspen (Figure 4). The 'tall stub' treatment consisted of full-girdling[1] the tree below the lowest live limbs and inoculating above this point with *G. applanatum*, *F. pinicola*, or *Fomes fomentarius* (only on trembling aspen). As well, these trees were topped at approximately 10-15 m height. Tall stubbing is intended to kill the tree, leaving a moderate height snag (i.e., a "stub tree") which will quickly develop heartrot decay as well as natural sap rot in the outer sapwood – the result is an ecologically useable snag in the near term (resembling a natural class 6 tree[2] in appearance), providing woody substrate for feeding and excavation of nest cavities.

Trees were inoculated three times for the dead top treatments, and six times for the window and tall stub treatments (i.e., inserted 3 or 6 cultured dowels in conjunction with the respective w treatment). All inoculation points were located within a 3-6 m vertical spread on the east or north sides of each tree bole.

For additional information concerning field methods, refer to Manning (2018) and Manning and Manley (2014).

[1] The girdling technique was modified in 2019 to a "double-stacked" girdle with approximately 15 cm between each of the two girdling cuts (**Figure 5**), as opposed to a single, wider girdle used in previous years' treatments. This technique change was recommended by Manning (2018) and is intended to more effectively sever the water conducting primary and secondary vascular xylem tissue.

[2] The BC MFLNRORD Forest and Range Evaluation Program (FREP) stand-level biodiversity monitoring protocol (http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/integrated-resource-monitoring/forest-range-evaluation-program/frep-monitoring-protocols/biodiversity) uses a 9-class coniferous tree classification system. Tree class 6 is a standing dead tree where approximately 1/3 to 1/2 of the original tree height has broken away. Stem wood condition in natural class 6 trees is soft, exhibiting moderate to advanced decay.

Figure 2. Applying a window treatment in a western larch at Wycliffe (Oct. 2019). This type of treatment is intended to introduce heart rot decay into the middle portion of the tree stem (at green arrow).

Figure 3. Tall stub treatment applied to a western larch (Wycliffe, Oct. 2019).

Figure 4. Tall stub treatment applied to a trembling aspen (at right). Note the naturally broken "stub tree" immediately to the left of the treated tree; this natural tree was measured and referenced as an untreated control tree for future comparative monitoring (Marl Creek, Oct. 2019).

Figure 5. "Double-stacked" ½ circumference girdles used in a window treatment on western larch (Wycliffe, Oct. 2019).

Results

In total, 90 trees [2 Douglas-fir (*Pseudotsuga menziesii*), 4 ponderosa pine (*Pinus ponderosa*), 41 western larch (*Larix occidentalis*) and 43 trembling aspen (*Populus tremuloides*)] were inoculated and mechanically modified in order to enhance or create wildlife tree habitat at the four Kootenay treatment sites between October 16-26, 2019.

Eleven trees received dead top treatments, 22 received window treatments, one received a combination treatment (dead top + window), while the majority of trees (56/90 or 62%) received tall stub treatments; a summary of these treatment statistics is shown in Table 1. A full data summary of all treated trees, including tree number, species, diameter at breast height, treatment type and associated inoculant fungus, and tree locations (UTM coordinates), is provided in Appendix 1 (separate document). All trees were live and in most cases appeared to be relatively healthy with no major visible stem damage or evidence of root disease at the time of pre-treatment.

Pre-treatment tree heights were variable, but ranged from approximately 13-35 m. Mean tree diameter at breast height (dbh outside bark, all trees) was 46.8 cm, with diameters ranging from 33.2 – 78.5 cm. The mean dbh of the largest cohort of treated trees was 45.2 cm (trembling aspen) and 47.6 cm (western larch).

Table 1. Summary of tree inoculation treatments (n=90) conducted in the Kootenay Region in 2019.

Location	Treatment Type			Tree Species[3]				Total
	Dead Top	Window	Tall Stub	Fd	Py	Lw	At	
Corn Creek	0	0	22	0	0	0	22	22
Marl Creek	0	0	21	0	0	0	21	21
Wycliffe (Luke Cr.)	4	9[4]	8	0	1	20	0	21
Wycliffe (Pine Butte Ranch area)	7	14	5	2	3	21	0	26
Total	**11**	**23**	**56**	**2**	**4**	**41**	**43**	**90**

[3] Fd = Douglas-fir; Py = ponderosa pine; Lw = western larch; At = trembling aspen
[4] One western larch tree at Luke Cr. received a "Combination" treatment, which is a Dead Top + Window

Control Treatments

In addition to the 90 mechanically modified and inoculated trees described above, 16 trees received "control treatments" as follows. None of the control trees were inoculated, however some were mechanically modified (e.g., tall stub treatment) while others were left completely untreated (i.e., no mechanical modifications and no inoculation). Refer to Appendix 1 for additional information on these control trees.

Corn Creek – 5 trembling aspen selected and described. No treatments, no inoculation.

Marl Creek – 5 trembling aspen selected and described. Three trees received a mechanical tall stub modification but were not inoculated; one tree received no mechanical modification or inoculation; one tree had snapped naturally and no modifications or inoculation were applied.

Wycliffe – 6 trees selected and described, including two western larch, one Douglas-fir and one trembling aspen. Each of these trees received one type of mechanical modification (i.e., dead topped, tall stub or window), but none were inoculated.

Discussion

Unlike previous years, the majority (84/90 or 93%) of the trees treated and inoculated in 2019 were western larch and trembling aspen. This was due to a conscious effort to target both larch and aspen since these two species have been under-represented in the overall wildlife tree creation/treatment population in the Kootenay region since 2007; the majority of treated trees up until present have been ponderosa pine and Douglas-fir. As well, more trembling aspen (43/90) were treated than in any previous years; all trembling aspen received tall stub treatments and were inoculated with either *G. applanatum* or *F. fomentarius*; both of these species of heartrot fungi will colonize dead aspen (Callan 1998), and it will be informative to compare trees inoculated with each fungus in the future, for evidence of decay and wildlife use.

The majority of trees (56/90 or 62%) treated in 2019 received tall stub treatments. Regardless of the tree species selected, tall stub treatment involves rapid severing of the sapwood vascular tissue via full girdling; as such the heartwood decay process is accelerated (Manning and Manley 2014, Manning 2013, Manning 2011) and the potential for use of the dead and decaying stemwood by cavity excavators increases. Based on observations of previously treated/inoculated trees in the Kootenay region in 2018 (see Manning 2018) and also from recent observations at Dutch-Findlay (2010 treatments, see Figure 6) and Fort Shepard (2014 treatments, see Figure 7), it appears that tall stub and dead top treatments are receiving quicker and much more substantial wildlife use (nest cavities and woodpecker feed excavations) than the window treatments thus far; this is consistent with the "shorter-term habitat supply objective" for tall stubs and dead tops described previously by Manning (2018) and Manning and Manley (2014).

The ecological benefits of both tall stub and dead top treatments are provision of dead-wood habitat structure within a short period of time (Manning and Manley 2014). This is particularly important in locations where "standing dead- wood structure", particularly larger diameter stems, are scarce due to past or forecasted removal (e.g., areas logged or cleared for timber harvesting, agriculture, hydro or other industrial development, urban-rural interface, wildfire-impacted areas).

Figure 6. Ponderosa pine dead top treatment from 2010 (tree #GT320) at the Dutch-Findlay site (E. Kootenay region, BC) as it appeared on Oct. 22, 2019. This tree had been inoculated with *Fomitopsis pinicola* and mechanically modified as a dead top treatment in Oct. 2010. The combination of topping, partial limbing and full girdling killed this tree. There were 8 woodpecker nest cavities in this tree, including a recent cavity likely from the 2019 breeding season (at green arrow). There were also 10 major (deep) feeding excavations and over 200 smaller probing-feeding excavations ranging along the entire length of the stub.

Figure 7. Ponderosa pine tall stub treatment from 2014 (tree #34) at Fort Shepard (W. Kootenay region, BC) as it appeared on Oct. 29, 2019. This tree had 3 nest cavities 1-3 m below the top (see one cavity at green arrow), as well as feeding excavations in the middle-section. These nest cavities are very near the fungal inoculation points with *F. pinicola*. Also note the full-girdle (red arrow) at mid-stem height which killed this tree and effectively terminated conductive moisture flow in the stemwood.

Recommendations

In order to improve the overall efficacy of future wildlife tree creation treatments and accompanying fungal inoculation techniques, some new recommendations are suggested below. These are based upon: i) observations of previously treated trees recently visited by Manning in October 2019; and ii) an improved understanding of heartwood fungi – tree host susceptibility to decay in relation to the inoculation treatment type (e.g., tall stub vs. window) and corresponding selection and application of fungal inoculant species.

1) Monitor future tree condition and wildlife use (i.e., stem breakage, presence of nest cavities, feeding excavations or fungal conks) of a sample of treated aspen trees at 3 years post-

treatment (ca. autumn 2022). This is important because of the large number (43) of trembling aspen treated in 2019 as tall stubs which should start showing evidence of decay sooner than treated coniferous trees; nearby control treatment aspen will provide useful comparative information.

2) In 2020 consider conducting some effectiveness evaluations of wildlife trees created in 2016 at Kikomon Provincial Park and Earl Ranch, and at Wigwam Flats from 2015. Particular emphasis should be on tall stub and dead top treatments at these locations.

3) When conducting wildlife tree creation and inoculation treatments, the following treatment parameters are recommended. Table 2 below is an update of similar guidelines provided previously by Manning (2018), but includes some new recommendations for tree species-specific fungal inoculants and inserted dowel counts[3] that should be employed going forward.

Table 2. Recommended fungal inoculant species for different tree species hosts and treatment types.

Host Tree Species	Recommended Fungal Inoculant	Treatment Type[4]				Number of Dowels Inserted	Comments
		TS	DT	W	C		
Western larch	*Fomitopsis officinalis*			x	x	6 W or 12 C	Combination treatment is a window AND a dead top placed in the same tree
	Fomitopsis pinicola or *F. officinalis*	x	x			9 TS, 6 DT	
Douglas-fir	*F. officinalis or Phellinus pini*[5]			x		6 W	Dead top section should be 3-4 m in length – inoculate 6 times. TS should be 8-15 m in height
	F. pinicola or Ganoderma applanatum	x	x			9 TS, 6 DT	
Ponderosa pine	*F. pinicola or G. applanatum*	x	x	N		9 TS, 6 DT	
Lodgepole pine	*F. pinicola*	x	N	N		9 TS	
White spruce	*G. applanatum or F. pinicola*	x	x	N		9 TS, 6 DT	
Black cottonwood, Balsam poplar	*Spongipellis delectans*	x	x	x		9 TS, 6 DT 6 W	Because of their scaffold branching form, Dead Top treatments in cottonwood and poplar involve stubbing, girdling and inoculating one or more of the large, vertical sweeping limbs. *P. populnea* is most damaging in living tree hosts and is therefore only suitable for Window treatments
	Pholiota populnea			x		6 W	
Trembling aspen	*Ganoderma applanatum or Fomes fomentarius*	x	N	N		9 TS	Select aspen which do NOT have any visible fungal conks (reproductive fruiting bodies) at the time of treatment

[3] Inserted dowel counts means the number of cultured wooden dowels inserted into the tree stem in conjunction with the relevant mechanical stem modification treatment (e.g., 9 dowels inserted for a tall stub treatment)

[4] TS = tall stub; DT = dead top; W = window; C = combination (W + DT)

x = Recommended treatment type

N = This treatment type is specifically not recommended for this tree species

[5] The scientific name for *Phellinus pini* has been changed to *Porodaedalea pini*

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All photographs courtesy of Todd Manning.

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